IMPLEMENTING ARRANGEMENT

CONCERNING IRRADIATION OF MATERIALS FOR THE GENERATION IV NUCLEAR SYSTEMS IN THE PHENIX REACTOR

Under the

Agreement between

The Department of Energy of the United States of America

and

The Commissariat à l'Energie Atomique of France

For Cooperation in Advanced Nuclear Reactor Science and Technology

The Department of Energy of the United States of America (DOE) and the Commissariat à l'Energie Atomique of France (CEA), hereinafter referred to as the "Parties";

NOTING the Agreement between the Department of Energy of the United States of America and the Commissariat à l'Energie Atomique of France for Cooperation in Advanced Nuclear Reactor Science and Technology of September 18, 2000 (the "Agreement"), which includes advanced reactor materials irradiation development and testing as an area of cooperation between the Parties;

NOTING that the Parties have respectively developed research programs in GENERATION IV nuclear systems, notably in the materials sector, and that CEA is operating the PHENIX experimental reactor for this purpose;

NOTING the Parties desire to perform an experimental irradiation project in the PHENIX experimental reactor, to test various types of materials under fast neutron fluence and high temperature and acquire data necessary to permit selection of the best-performing materials prior to any qualification program;

NOTING the Parties' determination to collaborate on a "FUTURIX MI" (MI: Inert Materials) program concerning the irradiation of several materials in the PHENIX reactor;

HEREBY AGREE AS FOLLOWS:

ARTICLE 1 - DEFINITIONS

For purposes of this Implementing Arrangement, the following definitions shall apply:

PROGRAM: the "FUTURIX MI" program concerning the irradiation of several materials in the PHENIX experimental reactor as defined in the technical and financial appendix attached to this Implementing Arrangement as Appendix I and constituting an integral part hereof. The PROGRAM constitutes "joint research" within the meaning of section II-B-2 (C) of Annex I to the Agreement.

RESULTS: manufacturing data as well as analyses results pertaining to irradiated materials and reference samples (not irradiated) arising from the PROGRAM, as well as data pertaining to the PHENIX experimental reactor required for RESULTS interpretation calculations.

KNOWLEDGE: all know-how, data, specifications, software or any other type of information necessary to perform the PROGRAM belonging to a Party prior to execution of the PROGRAM. A list of KNOWLEDGE is set forth in Appendix II attached to this Implementing Arrangement and constituting an integral part hereof.

ARTICLE 2 - PURPOSE

2.1 The purpose of this Implementing Arrangement is:

- to set out the terms and conditions according to which the Parties will collaborate to perform the PROGRAM, and

- to set out the rules governing the assignment of RESULTS ownership and the conditions limiting usage of same.

2.2 This Implementing Arrangement is subject to and governed by the Agreement. In case of any inconsistency between this Implementing Arrangement and the Agreement, the terms of the Agreement shall prevail.

ARTICLE 3 - PROGRAM FINANCIAL AND IN-KIND CONTRIBUTIONS

3.1 Contributions by the Parties, subject to the availability of appropriated funds and technologies, are:

3.1.1 DOE contributions, after deduction of the monetary value (to be mutually agreed by the Parties) of in-kind material provided, shall consist of:

- Contribution in cash covering 50% of the following costs:
  - manufacture and test/inspection of a special irradiation capsule, samples holder, boxes and experimental samples, with their extensions,
  - transportation of the whole capsule and boxes filled with experimental samples from Cadarache to PHENIX, and from PHENIX to the dismantling and non-destructive analysis laboratory,
  - procurement, assemblies, controls, disassemblies and non-destructive analysis necessary for the capsule, drafting the files and drawings associated with the irradiation device and CEA/PHENIX facility safety/criticality analyses,
  - irradiations (irradiation monitoring and analysis file).
- Supply of specific samples:
  - manufacture, test/inspection of specific experimental samples and determination of needed properties for technical and safety assessment
  - transportation of specific experimental samples to Cadarache
- Results of the GFR-F1 and GFR-F2 irradiation in the ATR experimental reactor.

3.1.2 CEA contribution shall consist of:

- Contribution in cash covering 50% of the following costs:
  - manufacture and test/inspection of a special irradiation capsule, samples holder, boxes and experimental samples, with their extensions,
  - transportation of the whole capsule and boxes filled with experimental samples from Cadarache to PHENIX, and from PHENIX to the dismantling and non-destructive analysis laboratory,
  - procurement, assemblies, controls, disassemblies and non-destructive analysis necessary for the capsule, drafting the files and drawings associated with the irradiation device and CEA/PHENIX facility safety/criticality analyses,
  - irradiations (irradiation monitoring and analysis file).

- Irradiations neutrons overall cost
- Preliminary design work on the new irradiation device for PHENIX (KMI device) and the content of the experimental irradiation.

3.2 The provisional PROGRAM schedule, including proposed contribution schedule, is described in detail in Appendix I.

3.3 Regarding the post-irradiation examination (PIE) of the samples, the Parties agree on the following:
- The PIE will be performed in both CEA and DOE laboratories, depending upon available examination devices, pending a repartition of the samples
- The results will be shared by the Parties according to Article 5.3.1.

ARTICLE 4 - FINANCIAL ACCOUNTING

4.1 The Parties estimate the total cost of the six-year PROGRAM will be 2,520,000 Euros as described in Appendix I.

Subject to Article 3.2, DOE's contribution to the PROGRAM will be payable in U.S. dollars, in 6 annual installments, within 60 days after receipt of invoices issued by CEA. The first invoice will be sent to DOE within 60 days of the date that this Implementing Arrangement enters into force. Each other annual invoice will be sent to DOE on the anniversary date of signature of this Implementing Arrangement. Each invoice will include U.S. dollar to Euro conversion charges, at the rate on such anniversary date, payable by DOE.

4.2 DOE will pay its contribution to the PROGRAM through a corresponding bank in accordance with applicable DOE financial disbursement procedures, directed to the following payee:

Commissariat à l'Energie Atomique
CEA / Saclay
Trésorerie
91191 Gif sur Yvette cedex (France

Bank account :
BNP, 3 place de la république, 91400 Orsay (France)
Account # 30004/00086/00021100040/68

ARTICLE 5 - MANAGEMENT

5.1 Tracking

5.1.1 Each Party will appoint a Contact who will be entrusted with management and continual tracking of the PROGRAM, including the exchanges of KNOWLEDGE. Each Contact will report to his/her management concerning the progress of the PROGRAM.

5.1.2 The Contacts will make an annual report on the progress of the PROGRAM to the Steering Committee established under Article 5 of the Agreement. If necessary to complete the PROGRAM, such financial report may include a recommendation for additional financial and/or in-kind contributions by the Parties or others.

5.2 **Exchange of KNOWLEDGE**

5.2.1 All KNOWLEDGE in the possession of the Parties necessary for the dimensioning of experimental samples, drafting of irradiation files (technical file and safety file), and interpretation of PIE results, will be exchanged in the form of referenced technical documents.

5.2.2 Technical documents will be circulated in the English language.

5.3 **Circulation of RESULTS**

5.3.1 Subject to the provisions of Article 3.2, all RESULTS pertaining to the manufacture of samples, characterisation of materials, measurements of materials properties, dimensioning and design of the irradiation device, irradiation safety and technical studies, and the history of irradiation at PIE will be circulated between the Parties in the form of technical reports.

5.3.2 Technical meetings of specialists will be held as often as required in order to ensure monitoring and correct performance of the PROGRAM. The location of said meetings will be jointly agreed by the Contacts. Minutes will be drafted for all meetings.

5.3.3 Reports and minutes will be drafted in the English language by the main actors. The latter are designated in Table 1 of Appendix I.

ARTICLE 6 - INTELLECTUAL PROPERTY

6.1 The protection and allocation of intellectual property arising under the activities conducted under this Implementing Arrangement shall be governed by Annex I to the Agreement.

6.2 A technology management plan within the meaning of section II.B. of Annex I to the Agreement is set forth in Appendix III attached to this Implementing Arrangement and constituting an integral part hereof.

ARTICLE 7 - LIABILITY

Without prejudice to Article 8 of the Agreement and in its capacity as the nuclear operator, CEA shall bear the financial consequences of its liability as provided for by the law and regulations of France concerning France's implementation of the Paris Convention on Third Party Liability in the Field of Nuclear Energy of July 29, 1960, and its protocols.

ARTICLE 8 - SHUTDOWN OF THE PHENIX REACTOR

8.1 In the event a decision is made to shut down operation of the PHENIX reactor, CEA shall notify DOE of said decision as quickly as possible by registered letter.

8.2 In the event of the shutdown of the PHENIX reactor, the Parties shall consult as soon as possible on the distribution of KNOWLEDGE generated and to be generated by the PROGRAM, the disposition of material utilized in the PROGRAM, and the disposition of unspent financial contributions in the possession of CEA.

ARTICLE 9 – TERM, AMENDMENT AND TERMINATION

9.1 This Implementing Arrangement shall enter into force upon signature and shall remain in force for 6 years, so long as the Agreement remains in force. It may be amended or extended by written agreement of the Parties, so long as the Agreement remains in force.

9.2 In the event of budgetary restrictions, significant restructuring and/or reorientation of a Party's programs, or in the event that access to a Party's facilities is limited for any reason whatsoever, or if a Party's performance of its undertakings under this Implementing Arrangement is prevented, limited or hindered by any other circumstance, the Parties will meet as quickly as possible in order to jointly agree to a revision of the Implementing Arrangement or its prolongation in time (to permit continuation of the PROGRAM to completion), or the early termination of the Implementing Arrangement, under conditions that are fair to the Parties.

9.3 The provisions set out in Article 7 shall remain in effect notwithstanding the expiration or termination of this Implementing Arrangement.

9.4 Either Party may terminate this Implementing Arrangement by giving 6 months written notice to the other Party.

9.5 Any activities not completed upon expiration of this Implementing Arrangement may be continued to completion under the terms of this Implementing Arrangement.

DONE in duplicate in the English language.

FOR THE DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA:

Date: 24 August 2005

Place: Washington DC

FOR THE COMMISSARIAT A L'ENERGIE ATOMIQUE:

Date: 7 September 2005

Place: Paris

APPENDIX I
TECHNICAL AND FINANCIAL APPENDIX

TECHNICAL APPENDIX:

Experimental grid

The irradiation experimental grid was commonly defined and approved by all PROGRAM participants (CEA and DOE). Said grid comprises:

- 8 experimental materials defined by Idaho National Laboratory (INL) and CEA comprising:
  - α-SiC
  - β-SiC
  - ZrC :
  - TiC
  - TiN
  - ZrN
  - Mo-Ti-Zr-C and Mo-Zr-B
  - Composits: SiC(fibers)/SiC
  - Nb-1Zr

- Specific samples geometry:
  - Small disk
  - Tem specimen
  - Cylinder
  - Small beam

The experimental samples will be mounted in special sample holder, then in experimental boxes and finally the boxes stack in a special material irradiation device (KMI capsule). Sample holders are designed to contain all the samples with its specific geometry and the design of boxes is made to reach high temperature (~1000°C) in the samples by gamma power deposition.

Irradiation is scheduled for the two last reactor cycles, that is, insertion into the reactor planned at the end of 2006 (for a PHENIX restart in end 2003). The irradiation length represents a fast fluence (E>0,1MeV) of 1.10 10^{27}n.m^{-2}.

Technical content

The technical content covers the manufacturing, irradiation and post-irradiation examination results of the experimental materials and all the capsule structures. It covers:

1. Procurement by CEA of 12 of the experimental materials and manufacturing of material sample in order to reach the right geometry for the irradiation.
2. Procurement by CEA of all the structures of the capsule (sample holder, boxes and capsule).

3. Procurement by INL of 5 of the experimental materials and manufacturing of material sample in order to reach the right geometry for the irradiation.
4. Measurements of all properties needed for the PHENIX safety reports, as well as tests to ensure the compatibility of all materials that may be in contact, CEA and DOE provide these results for its own materials.
5. Manufacturing sample holders and boxes.
6. Filling of samples holder with experimental samples, filling boxes with samples holders, welding, test/inspection and all reports associated with said operations.
7. Manufacture of the capsule by CEA with the associated controls.
8. Drafting of all contractual files under quality assurance (ISO 9001 standard[1]).
   - with respect to PHENIX: presentation file, technical file, safety file, manufacturing report and deviation processing,
   - with respect to manufacturers: specifications and drawings.

   All the files and reports will be written by CEA, with the exception of the manufacturing reports which will be written by each manufacturer. In the context of file requirements, participants' KNOWLEDGE associated with their national programs will be exchanged.
9. Transportation of experimental boxes from Cadarache to the PHENIX plant,
10. Irradiation in the PHENIX reactor,
11. Dismantling capsule.
12. Transportation of irradiated experimental samples from the PHENIX plant to participants' post-irradiation examination laboratories (CEA, DOE). The post irradiation examination will be discussed until the end of the irradiation: CEA and DOE may take half of the irradiated samples.
13. Results of post-irradiation examination for all experimental samples irradiated in participating laboratories. Analyses results will be shared by the Parties.

[1] PAQP 2003 ind 0

KEY DATES

- Handing over of the technical file to PHENIX: February 2005
- Acceptance testing of samples: January 2006
- Insertion into reactor: January 2007
- Removal from reactor: November 2008
- Post-irradiation examinations from 2009

This schedule is dependent on PHENIX operation and may be revised.

FINANCIAL APPENDIX

Table No. 2 provides the schedule for expenditure and distribution of expenditure between the Parties.

FUTURIX-MI: irradiation of inert materials for Gas Fast Reactor
CEA COST AND SCHEDULE

TASKS	2003	2004	2005	2006	2007	2008	2009	Total
	invest+manpower	invest+manpower	invest+manpower	invest+manpower	invest+manpower	invest+manpower	invest+manpower	
SAMPLES								
material supply	*90*	40						40
sample fabrication	*410,3*	61,2						61
R&D support: caract., propert.	*194,1*	81,5	62,3					144
CAPSULE								0
fabrication of the capsule and samples supports		208,2	155,7					364
capsule mounting			0	201,5				202
REPORTS for Phénix								0
Design, Planning., Q.A., Fab. Following	*188,3*	290,1	124,9	256,2				671
Ordonnancement des fabrications	*20*	67,3	77,6	97,9				243
Transports			0					0
IRRADIATION in Phénix								0
reports analysis, irradiations management	*50*	46	205		91	91		433
neutrons cost	**FREE**							0
irradiation following				50,9	85,95	85,95	85,95	309
POST IRRADIATION								0
capsule dismantling							24	24
transport							30	30
PIE + interpretation (to be defined)	PIE shared and all results							0
Total Futurix MI	*952,7*	**794,3**	**625,5**	**606,5**	**176,95**	**176,95**	**139,95**	**2 520** k€

Financial repartition								
CEA	*952,70*	794,80	373,50	354,50	-75,05	-75,05	-112,05	1 260,65
DOE		0,00	252,00	252,00	252,00	252,00	252,00	1 260,00

Year 2003:
CEA initial contribution

APPENDIX II
LIST OF KNOWLEDGE

KNOWLEDGE exchange pertains to:

1. Material specifications and manufacturing procedures relevant to the fabrication of fuels for the FUTURIX-MI experiment and including the R&D phase on fabrication process optimisation,
2. The characteristics and physico-chemical properties of new and irradiated FUTURIX-MI materials, required for the materials modelling and design studies of the FUTURIX-MI experimental samples,
3. Laws and behavioural models concerning FUTURIX-MI materials under irradiation in normal operation, incident and accident modes, required for the mandatory technical and safety files,
4. Post-irradiation examination performed on FUTURIX-MI samples, interpretation of examination results, and materials modelling performed with the codes developed by each participant.

APPENDIX III
TECHNOLOGY MANAGEMENT PLAN

Ownership rights

Each Party shall remain the owner of KNOWLEDGE, whether patented or not, that it held prior to execution of the Implementing Arrangement.

RESULTS, other than inventions, arising from the PROGRAM shall be construed as owned by the Party creating the RESULTS. However, each Party may use or reproduce said RESULTS without the consent of the other Party. With respect to publication or disclosure of said RESULTS, except for manufacturing data, any such RESULTS delivered to one Party shall be subject to the unlimited right to publish or disclose such RESULTS for any purpose.

For inventions, i.e., subject matter that is or may be patentable, the Parties shall jointly agree to an equitable allocation of rights and responsibilities within a reasonable time from the time a Party becomes aware of the creation of an invention, taking into account the relative contributions of the Parties, and other factors deemed appropriate.

Usage of RESULTS

Each Party will have the right to make use of RESULTS, patented or not, obtained within the framework of the PROGRAM for its own research requirements free of cost.

The industrial and commercial usage of RESULTS, patented or not, may be performed through transfer of license or licenses to third parties.

Licenses may be transferred by a Party or any third party designated by the latter. The licensee and main license terms and conditions should be established in consideration of market conditions and the joint interest of the Parties.